



US009118714B1

(12) **United States Patent**  
**Thomson et al.**

(10) **Patent No.:** **US 9,118,714 B1**  
(45) **Date of Patent:** **Aug. 25, 2015**

(54) **APPARATUSES, METHODS AND SYSTEMS  
FOR A CYBER THREAT VISUALIZATION  
AND EDITING USER INTERFACE**

(56) **References Cited**  
U.S. PATENT DOCUMENTS

(71) Applicant: **Lookingglass Cyber Solutions,**  
Baltimore, MA (US)  
(72) Inventors: **Allan Thomson,** Pleasanton, CA (US);  
**Christopher D. Coleman,** Centreville,  
VA (US)

8,286,239 B1 *	10/2012	Sutton	726/22
8,413,244 B1 *	4/2013	Nachenberg	726/23
8,595,845 B2 *	11/2013	Basavapatna et al.	726/25
8,776,180 B2 *	7/2014	Kumar et al.	726/3
2014/0041028 A1 *	2/2014	Ramsey et al.	726/22

\* cited by examiner

(73) Assignee: **Lookingglass Cyber Solutions, Inc.,**  
Baltimore, MD (US)

*Primary Examiner* — Hosuk Song  
(74) *Attorney, Agent, or Firm* — Cooley LLP

(\*) Notice: Subject to any disclaimer, the term of this  
patent is extended or adjusted under 35  
U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/339,441**  
(22) Filed: **Jul. 23, 2014**

(51) **Int. Cl.**  
**G06F 11/00** (2006.01)  
**H04L 29/06** (2006.01)

(52) **U.S. Cl.**  
CPC ..... **H04L 63/1441** (2013.01)

(58) **Field of Classification Search**  
CPC ..... H04L 63/1416; H04L 63/1425; H04L  
63/1433; H04L 63/1441; H04L 63/145;  
H04L 63/20; H04L 63/1408  
USPC ..... 726/22–25; 709/223–225  
See application file for complete search history.

(57) **ABSTRACT**

The cyber threat intelligence confidence rating visualization and editing user interface technology (hereinafter “TIC”) provides a user interface that allows a user (e.g., a cyber threat analyst, etc.) to submit ratings for various characteristics associated with a cyber threat indicator. In one embodiment, the TIC may instantiate a user interactive risk evaluation component having a user interface input element for a user to submit calculation weights for one or more characteristics of a cyber threat; generate a graphical representation of a cyber threat confidence score for user interface display via the user interactive risk evaluation component; and dynamically adjust the graphical representation of the threat confidence score using at least one of the one or more characteristics weighted by the user configured weight.

**17 Claims, 10 Drawing Sheets**

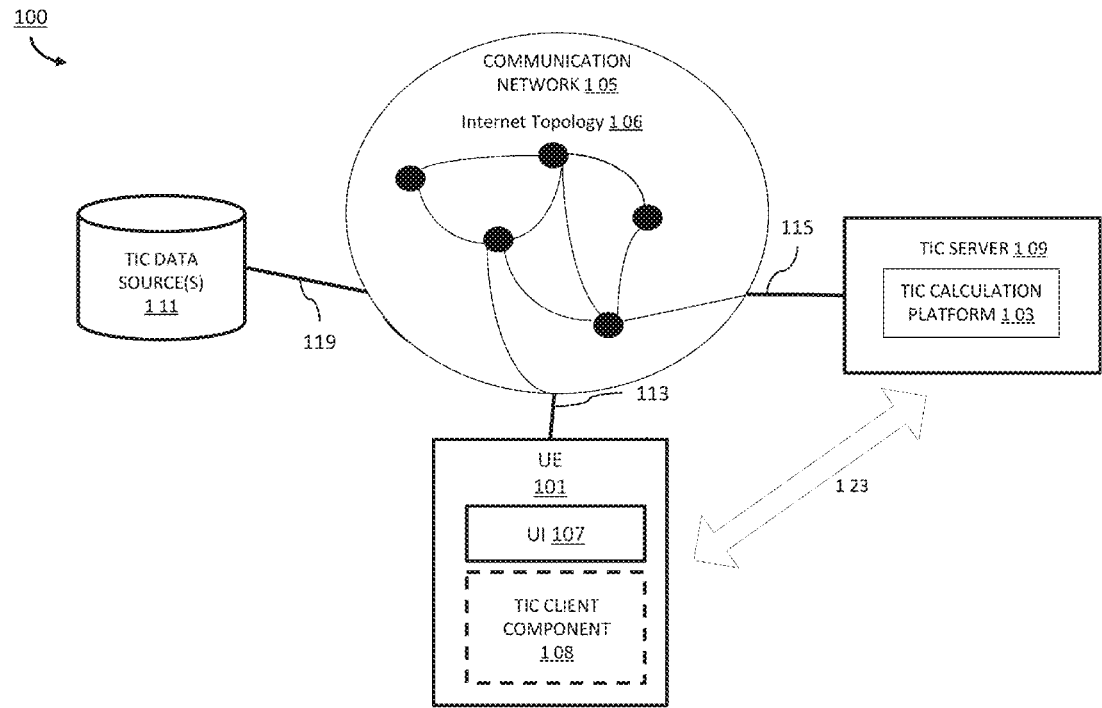
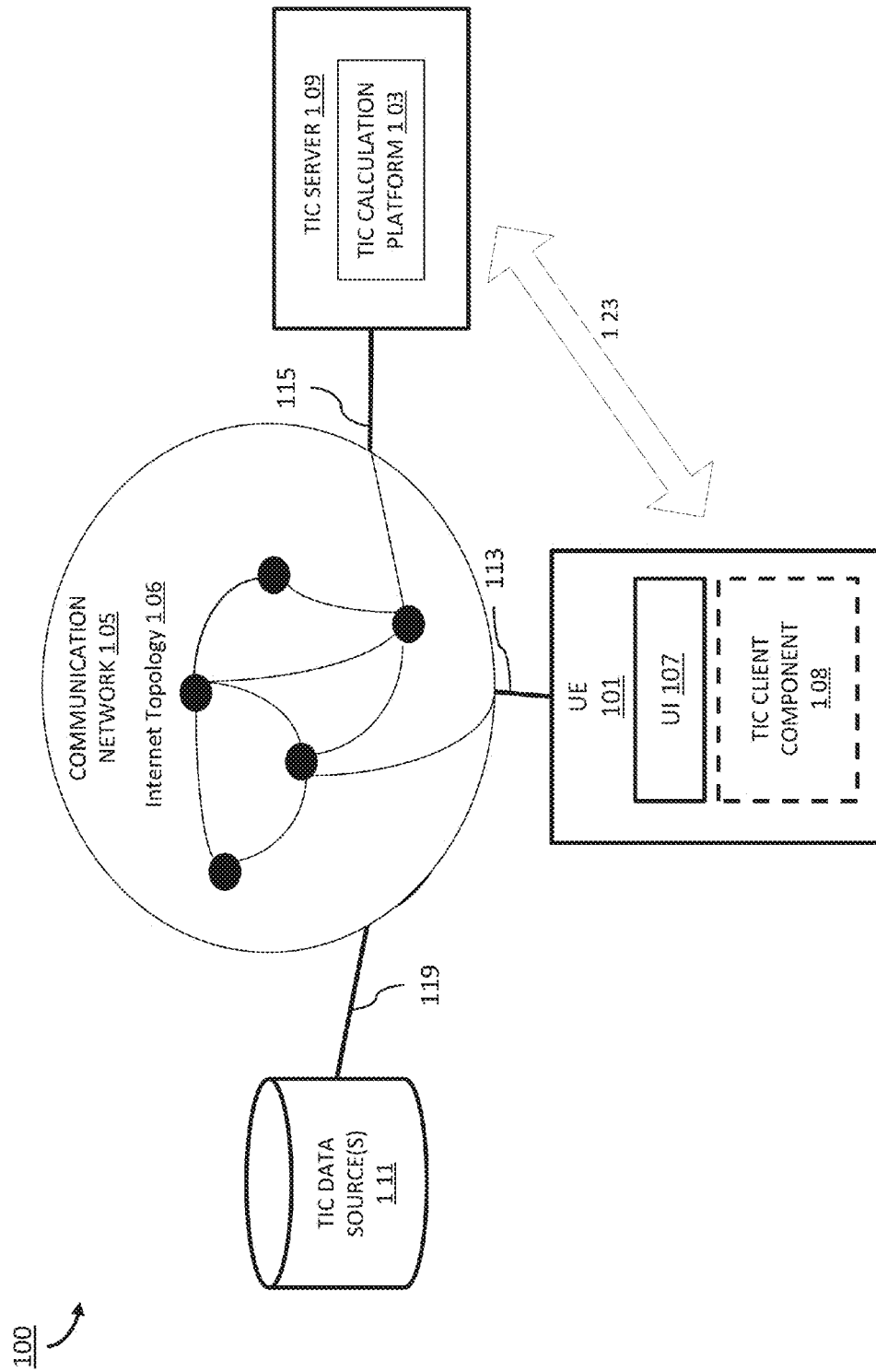


FIG. 1A



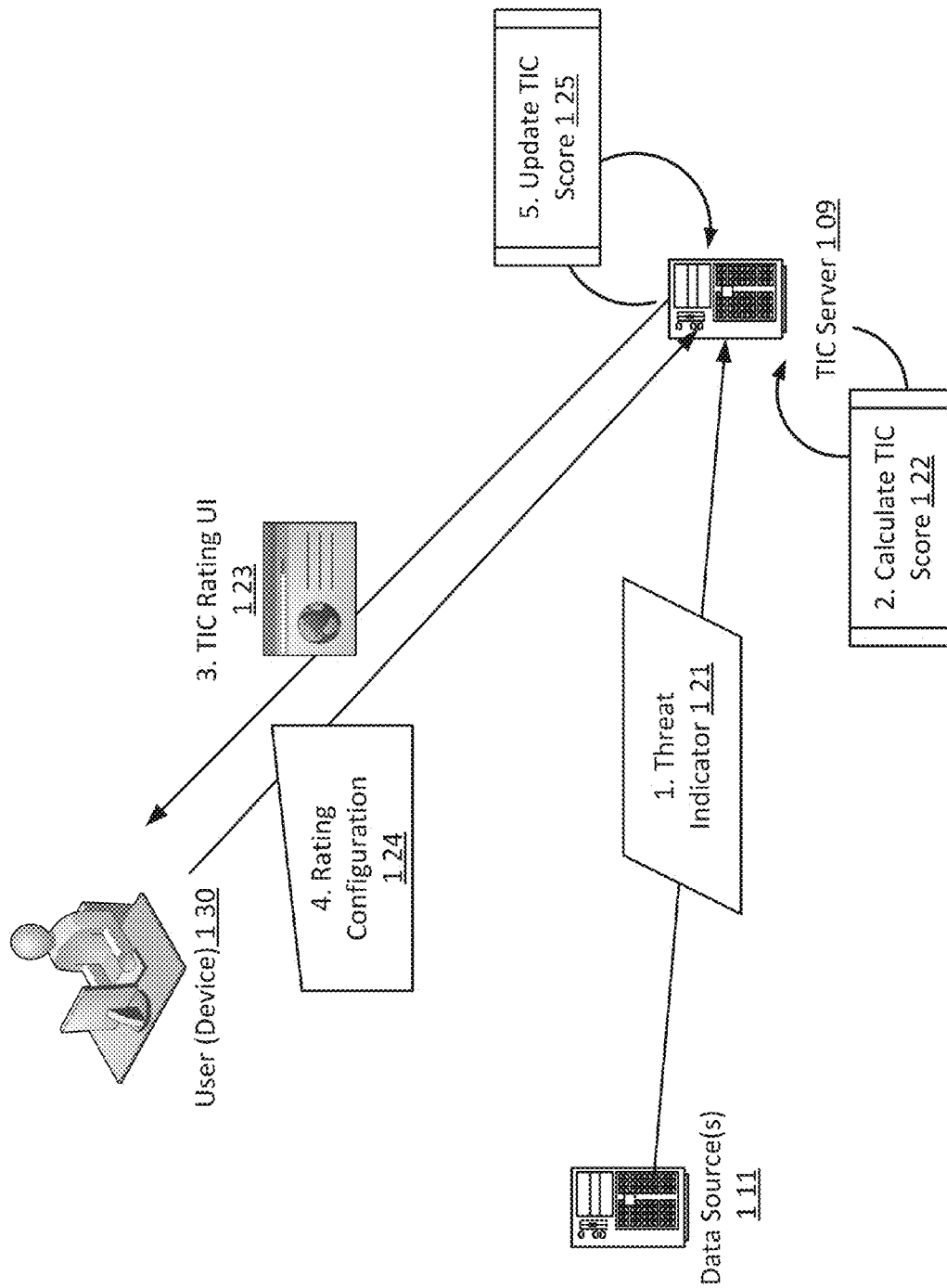
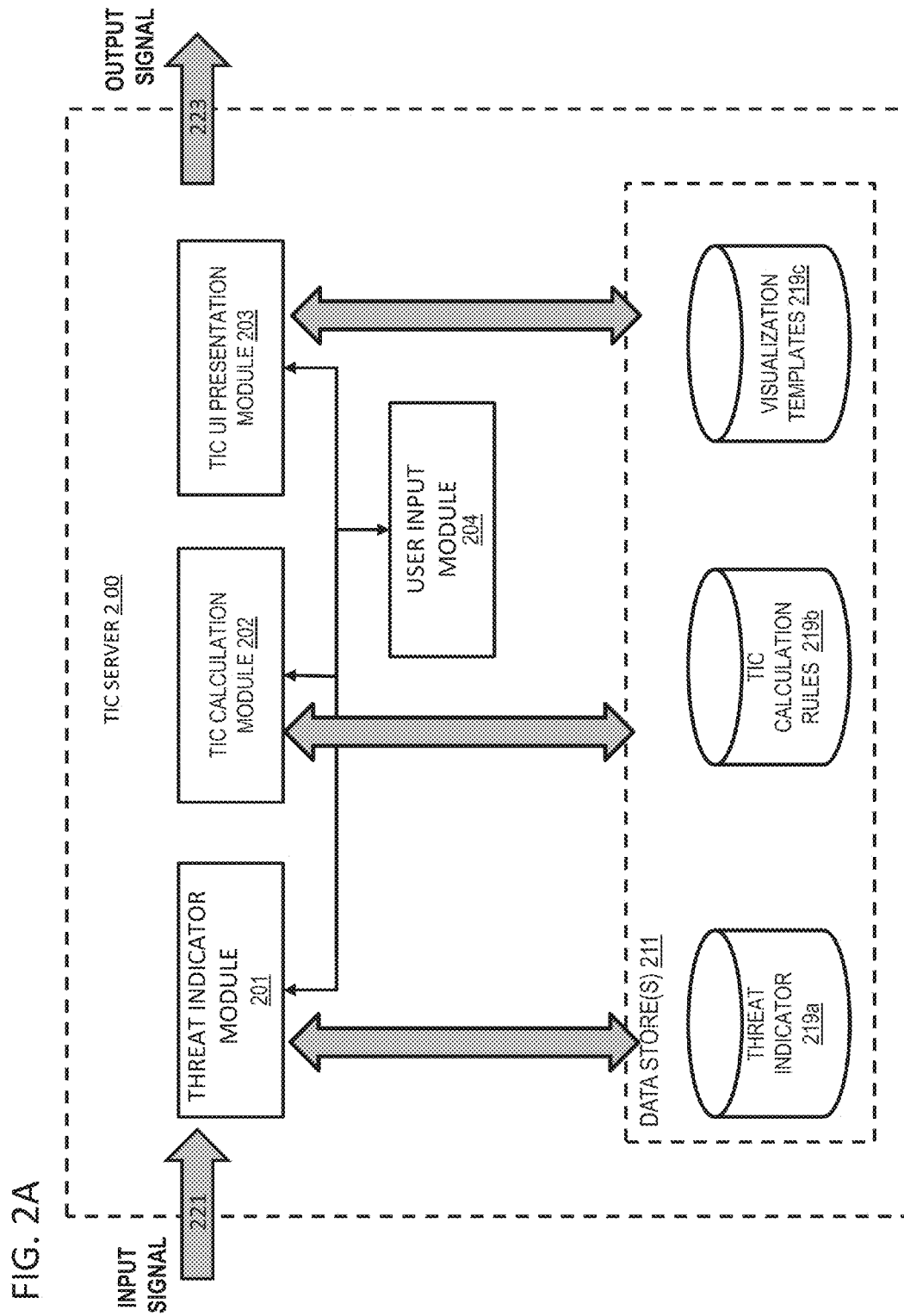


FIGURE 18



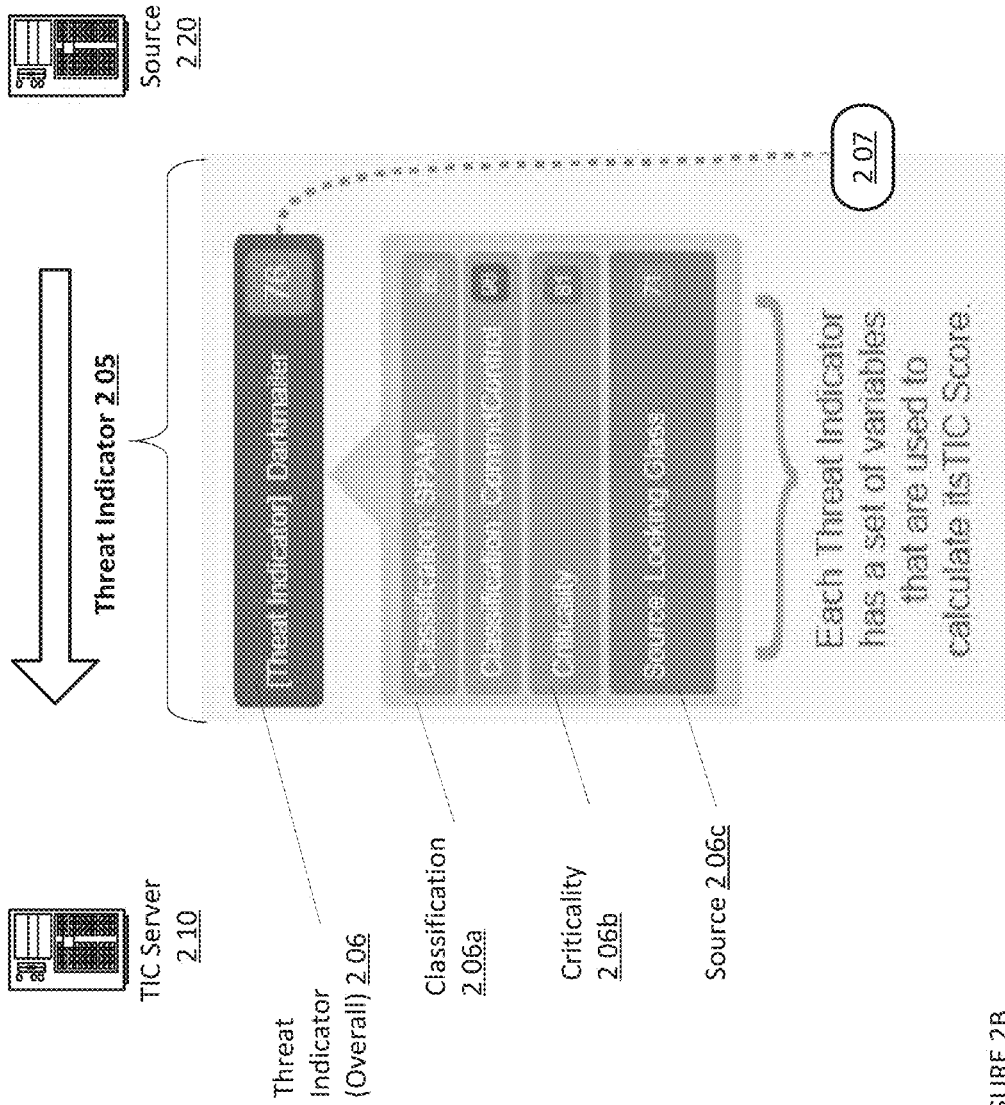


FIGURE 2B

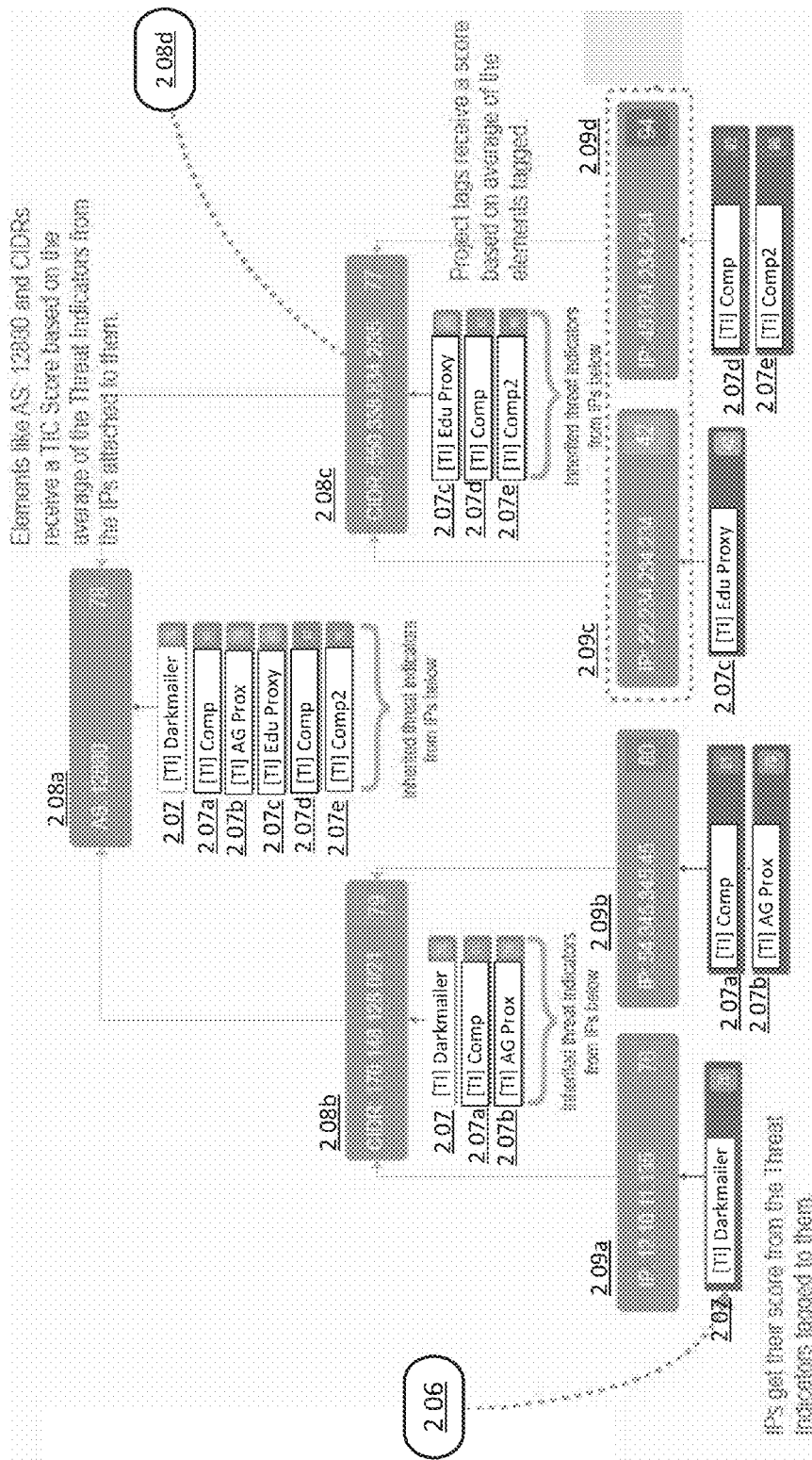
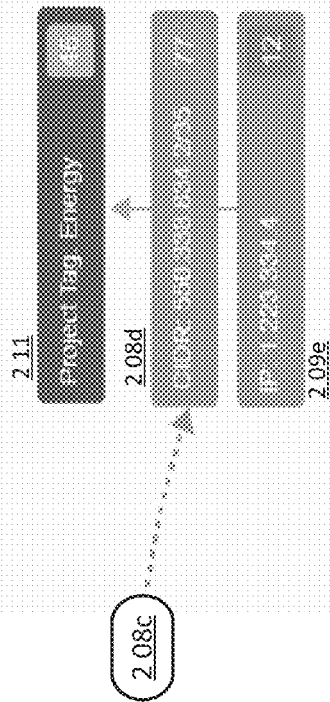


FIGURE 2C

### How Project Tags receive a TIC Score



### How FQDNs receive a TIC Score

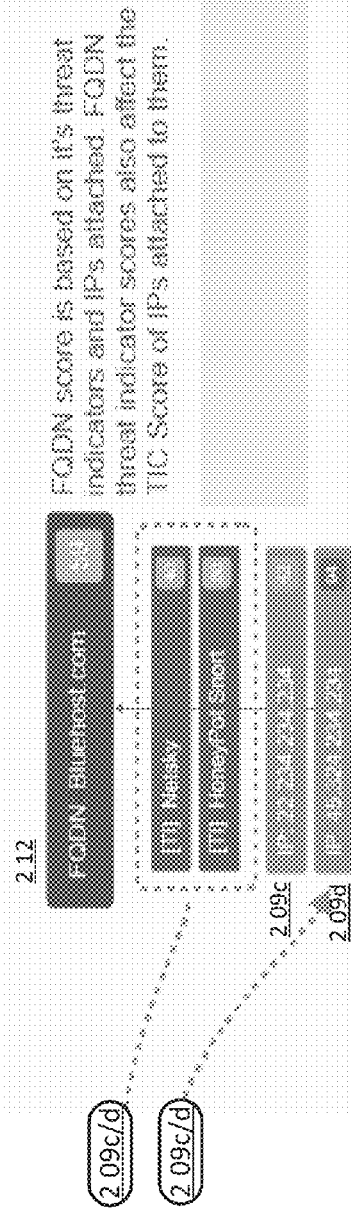


FIGURE 2D

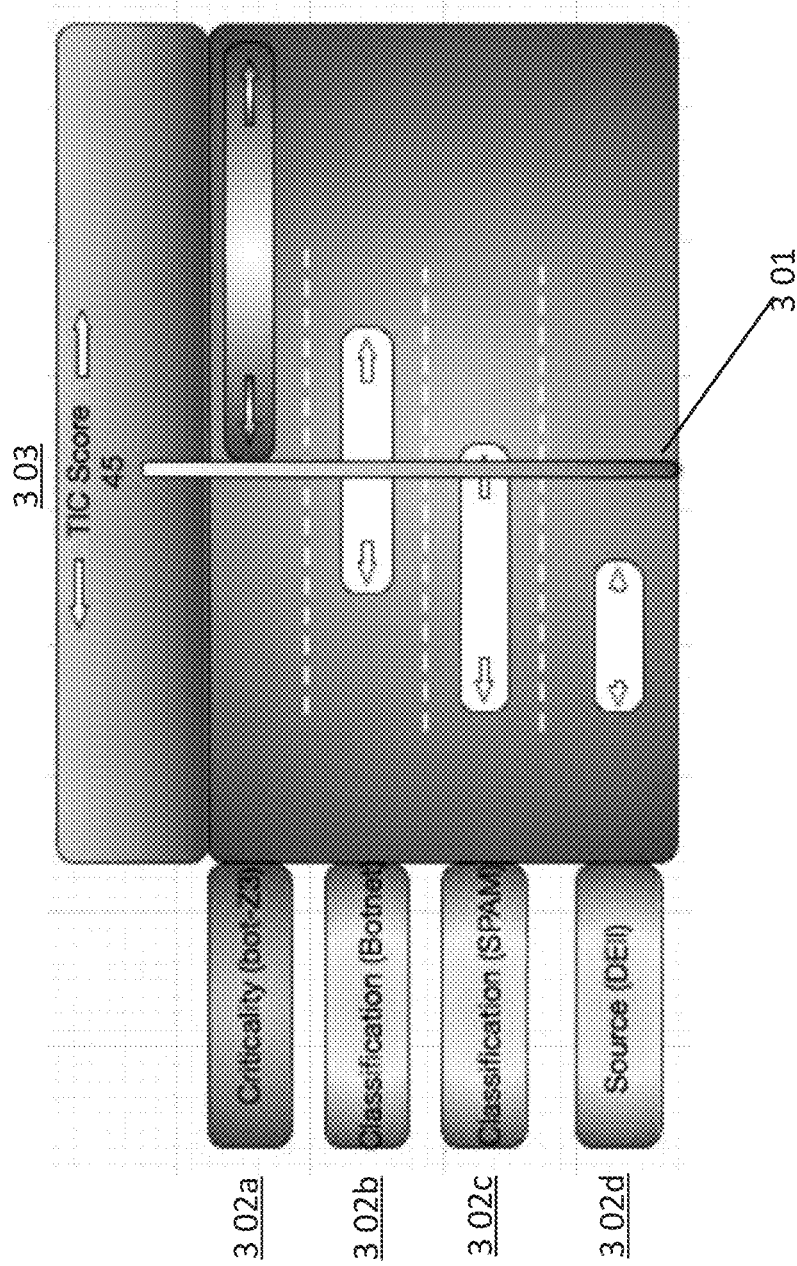


FIGURE 3A



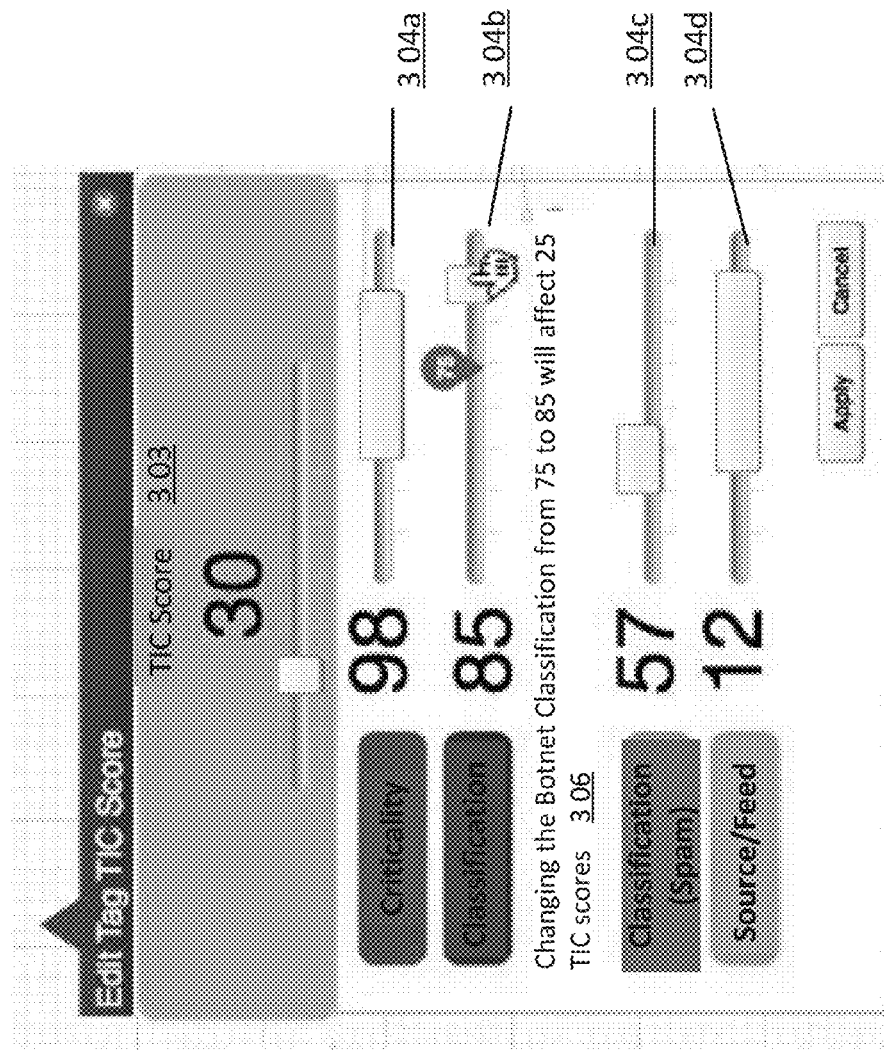


FIGURE 3B

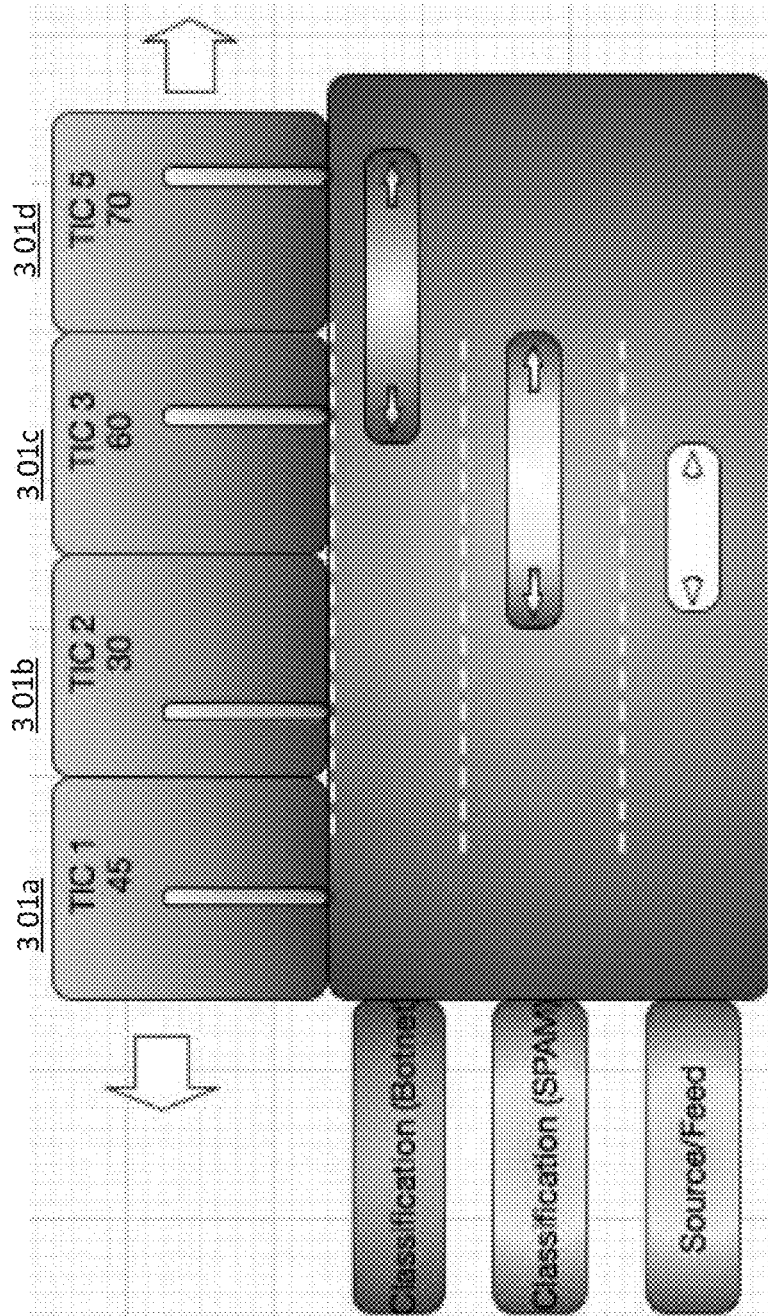


FIGURE 3C

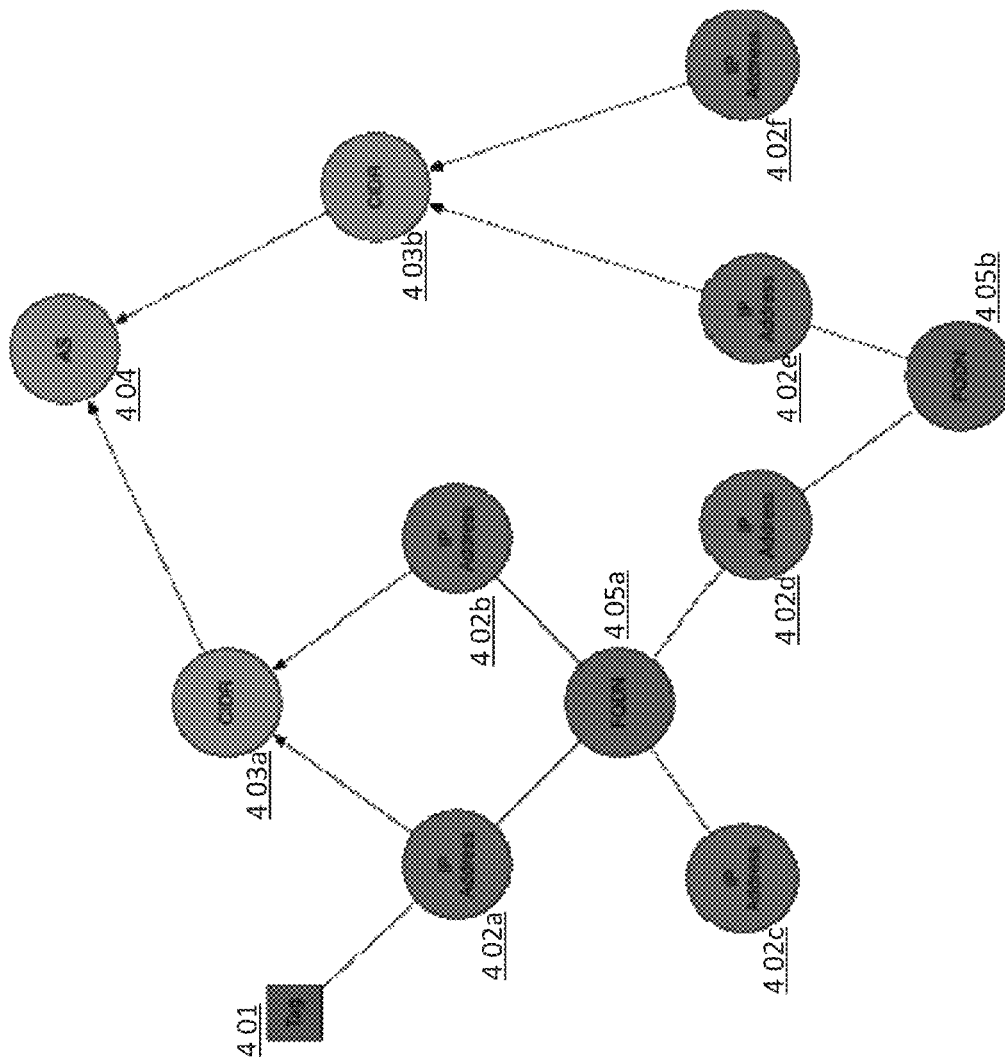


FIGURE 4

1

## APPARATUSES, METHODS AND SYSTEMS FOR A CYBER THREAT VISUALIZATION AND EDITING USER INTERFACE

This application may contain material that is subject to copyright, mask work, and/or other intellectual property protection. The respective owners of such intellectual property have no objection to the facsimile reproduction of the disclosure by anyone as it appears in published Patent Office file/records, but otherwise reserve all rights.

### FIELD

Some embodiments generally relate to apparatuses, methods, and systems for cyber security management, and more particularly, relate to a cyber threat confidence rating visualization and editing user interface ("TIC").

### BACKGROUND

Computer malware is a type of software that disrupts the normal operation of a computer. A malware instance can send malicious code programs to a computer so as to burden the processing capacity of the computer, gain access to secured data without authorization, or modify critical system settings. Anti-malware programs are designed to detect potential threats of malware.

### BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying appendices, drawings, figures, images, etc. illustrate various example, non-limiting, inventive aspects, embodiments, and features ("e.g.," or "example(s)") in accordance with the present disclosure.

FIG. 1A provides a schematic block diagram of a communication network system in which TIC aspects can be provided, according to an embodiment.

FIG. 1B provides a block diagram illustrating aspects of providing a threat indicator confidence score rating user interface (UI) to a user, according to one embodiment of the TIC.

FIG. 2A is a schematic illustration of TIC components and/or modules, according to an embodiment.

FIGS. 2B-2D provide diagrams illustrating data structure of calculating a threat indicator confidence score, according to one embodiment of the TIC.

FIGS. 3A-3C provide example UI screens illustrating aspects of an interactive threat indicator confidence score rating editor, according to one embodiment of the TIC.

FIG. 4 provides a network infrastructure diagram illustrating propagating a threat indicator tag through a network, according to one embodiment of the TIC.

The leading number of each reference number within the drawings indicates the figure in which that reference number is introduced and/or detailed. As such, a detailed discussion of reference number 101 would be found and/or introduced in FIG. 1. Reference number 201 is introduced in FIG. 2, etc.

### SUMMARY

In one embodiment, the TIC may instantiate a user interactive risk evaluation component having a user interface input element for a user to submit calculation weights for one or more characteristics of a cyber threat; generate a graphical representation of a cyber threat confidence score for user interface display via the user interactive risk evaluation component; and dynamically adjust the graphical representation

2

of the threat confidence score using at least one of the one or more characteristics weighted by the user configured weight.

### DETAILED DESCRIPTION

The cyber threat intelligence confidence rating visualization and editing user interface technology (hereinafter "TIC") provides a user interface that allows a user (e.g., a cyber threat analyst, etc.) to submit ratings for various characteristics associated with a cyber threat indicator.

For example, threat indicators are associated with one or more internet hosts indicating that host has some form of risk associated with it (e.g., a risk assessment score, or a threat indicator confidence score may be either positive or negative with respect to the risk associated with a network, etc.); an individual indicator can be provided by one data source and characterized by that data source in terms of severity of the risk associated with the threat indicator and categories of the risk associated with the threat indicator. Such data sources may be a threat monitoring source, a target host, and/or the like. The TIC can use a combination of the data source(s), threat indicator classification(s) and severity of the threat indicator into an overall risk score representing a confidence level of the received threat indicator. In another example, a threat indicator confidence score (TIC score) can be the result of a single threat indicator, or a score on a network element where the score is the combined score of all of the threat indicator TIC scores associated with the network element.

In some embodiments, those threat indicators and their associated risk score may not be accurate and a cyber analyst may modify the threat indicator's risk score, e.g., by manually adjust a rating, a weight parameter, etc. of the risk score based on the cyber analyst's experience. The TIC provides an intuitive UI for allowing the cyber analyst to modify and edit the risk score characteristic ratings and weights.

FIG. 1A provides a schematic block diagram of a communication network system in which TIC aspects can be provided, according to an embodiment. A communication network system 100 can include one or more user devices or user equipments (UEs) 101, each equipped with at least a user interface (UI) 107; one or more TIC servers 109 including a TIC calculation platform 103; one or more data source(s) in, which are connected via a communication network 105 (that may include Internet topology information 106, etc.). Any of the devices or platforms of the communication network system 100 can be equipped with local memory/storage spaces (not shown in FIG. 1A). Furthermore, the devices and platforms of the network system 100 may have access to centralized or distributed memory/storage spaces (not shown in FIG. 1A) through the communication network 105. Thus, FIG. 1A is merely an example illustrating the types of devices and platforms that can be included within a communication network system 100.

Communication network 105 can be any communication network, such as the Internet, configurable to allow the one or more UEs 101, the one or more TIC servers 109, and the TIC data sources 111 to communicate with communication network 105 and/or to each other through communication network 105. Communication network 105 can be any network or combination of networks capable of transmitting information (e.g., data and/or signals) and can include, for example, a telephone network, an Ethernet network, a fiber-optic network, a wireless network, and/or a cellular network.

In some instances, communication network 105 can include multiple networks operatively coupled to one another by, for example, network bridges, routers, switches and/or gateways. For example, the UEs 101 can be operatively

3

coupled to a cellular network; and the TIC data source(s) 111 can be operatively coupled to a fiber-optic network. The cellular network and fiber-optic network can each be operatively coupled to one another via one or more network bridges, routers, switches, and/or gateways such that the cellular network, the Ethernet network and the fiber-optic network are operatively coupled to form a communication network. Alternatively, the cellular network and fiber-optic network can each be operatively coupled to one another via one or more additional networks. For example, the cellular network and the fiber-optic network can each be operatively coupled to the Internet such that the cellular network, the fiber-optic network and the Internet are operatively coupled to form a communication network.

As illustrated in FIG. 1A, UEs 101 are operatively coupled to communication network 105 via network connection(s) 113; TIC servers 109 are operatively coupled to communication network 105 via network connection(s) 115; and data source(s) 111 are operatively coupled to communication network 105 via network connection(s) 119. Network connections 113, 115, and 119 can be any appropriate network connection to operatively couple UEs 101, the TIC servers 109, and the data source(s) 111. Furthermore, the TIC server 109 can have a direct connection with the UEs 101 via a communication 123.

A network connection can be a wireless network connection such as, for example, a wireless fidelity (“Wi-Fi®”) or Wireless Local Area Network (“WLAN”) connection, a Wireless Wide Area Network (“WWAN”) connection, and/or a cellular connection. A network connection can be a wired connection such as, for example, an Ethernet connection, a Digital Subscription Line (“DSL”) connection, a broadband coaxial connection, and/or a fiber-optic connection.

As mentioned above, in some instances, a communication network system 100 can include more than one UE 101, more than one TIC server 109, and more than one data source 111. A UE 101, and/or a TIC server 109, each of which can be operatively coupled to the communication network 105 for example by heterogeneous network connections. For example, a first UE 101 can be operatively coupled to the communication network 105 by a WWAN network connection, another UE 101 can be operatively coupled to the communication network 105 by a DSL network connection, and a TIC server 109 can be operatively coupled to the communication network 105 by a fiber-optic network connection.

The TIC server(s) 109 each can be, for example, a web server configured to provide search capabilities to electronic devices, such as UEs 101. The UE 101 can be in communication with the TIC server(s) 109 via the communication network 105, while the communication is managed by the TIC client component 108. In one implementation, the TIC server(s) 109 can be a remote server housed separately from the UE 101, where the TIC client component 108 can include an application (e.g., a browser application, a mobile application, etc.) instantiated on a user device (e.g., a Smartphone, a computer, a workstation, a personal digital assistant, etc.). For example, the TIC client component 108 can send a signal representing a control command (e.g., user submitted parameters, etc.) to the TIC server(s) 109 for TIC score calculation (which can be performed by the TIC calculation platform 103), where the results of the calculation may be presented via the UE 101. In another example, the TIC calculation platform 103 at a TIC server 109 can calculate a TIC score on the global internet topology 106 of the communication network 105, and a TIC client component 108 at the UI 101 can receive the TIC score via the communication network 105. In another implementation, the TIC server(s) 109 may be inte-

4

grated with the UE 101 including the TIC client component 108. For example, the TIC server 109 and UE 101 may act as an integrated computing device operated by a user, and communicate with various entities such as a user, data source, and/or the like, for cyber threat analytics. A detailed discussion of functional module(s) and data store(s) of the TIC server 109 (e.g., when integrated with a UE 101) is provided in FIG. 2A.

The UEs 101 can be any of a variety of electronic devices that can be operatively coupled to communication network 105. A UE 101 can be, for example, a personal computer, a tablet computer, a personal digital assistant (PDA), a cellular telephone, a portable/mobile internet device, television, kiosk display, display screens in vehicles, projection devices, laser display devices, digital display watches, digital display glasses and/or some other electronic communication device with audio and/or visual capabilities. A UE 101 can also be, for example, a television set, a streamer device, a set top box, or any other electronic device equipped with a display unit (a UI 107) and a network connection 113 that enables the device to run applications with real-time contents received via the network connection 113 on an operating system. The UEs 101 each can include a web browser configured to access a webpage or website, for example, the TIC client component 108, which can be accessible over communication network 105. The UEs 101 can be configured to support, for example, HyperText Markup Language (HTML) using JavaScript. For example, the UEs 101 can include a web browser, such as, Firefox®, Safari®, Dolphin®, Opera®, Internet Explorer (IE)®, Chrome® and/or similar browsers. An Internet page or website can be accessed by a user of a web browser at a UE 101 by providing the web browser with a reference such as a uniform resource locator (URL), for example, of a webpage. For example, a user of a UE 101 can access a TIC server 109 via a URL designated for the TIC server 109. In some instances, UEs 101 each can include specialized software other than a browser for accessing a web server such as, for example, a TIC server 109. Specialized software can be, for example, a specialized network-enabled application or program. In some instances, portions of a website accessible via a web server can be located in a local or remote memory space/data store accessible to the web server. A UE 101 can also include a display, monitor or user interface (UI) 107, a keyboard, various ports (e.g., a USB port), and other user interface features, such as, for example, touch screen controls, audio components, and/or video components (each not shown).

Data source(s) 111 can be distributed sources of data throughout the communication network system 100. A data source 111 can be one or more of a database, a data warehouse, a file, etc.

FIG. 1B provides a block diagram illustrating aspects of data flows between the TIC server (e.g., 109 in FIG. 1A) and related entities, according to one embodiment of the TIC. In one embodiment, the TIC server 109 may receive a threat indicator 121 from a data source (e.g., a threat monitor source, a host target, etc.) 111, and/or a cyber threat analytics source, and/or the like. The threat indicator 121 may identify a potential cyber threat to a target host, and may include characteristics of the identified cyber threat and a rating associated with characteristics and/or parameters of the threat indicator. Example threat indicator characteristics/parameters include, but not limited to a criticality rating of the threat indicator, a classification of the threat indicator, source information of the threat indicator, and/or the like. An example data structure of the threat indicator 121 is provided, for example, at 205 in FIG. 2B.

5

Returning to FIG. 1B, the TIC server **109** can then calculate a TIC score **122**, which indicates a confidence level with regard to the threat indicator **121**. Further details of calculating a threat indicator confidence score are provided in FIGS. 2C-2D and 4.

Upon obtaining a threat indicator confidence score, the TIC server **109** may generate and provide a cyber threat confidence rating visualization and editing user interface **123** to a user (operating a user device) **130**. In one implementation, the user/user device **130** may submit a rating configuration **124** via the TIC rating UI **123** to the TIC server **109**. Example TIC rating UIs and user interactions are further provided in FIGS. 3A-3C.

The TIC server **109** may update the TIC score based on the submitted rating configuration **124**, e.g., at **125** following similar procedures as calculating a TIC score at **122**. Further discussion of the TIC asset scores are provided in FIGS. 2C-2D.

FIG. 2A is a schematic illustration of TIC components and/or modules of a TIC server (e.g., **109** in FIG. 1A), according to an embodiment. The TIC server **200** can be similar to the TIC server **109** of FIGS. 1A-B. As shown in FIG. 2A, a TIC server **200** can include a threat indicator module **201**, a TIC calculation module **202**, a TIC UI presentation module **203**, a user input processing module **204**, and/or the like. A data store(s) **211** can include a threat indicator table **219a**, TIC calculation rules **219b**, visualization templates **219c**, and/or the like. Furthermore, the TIC server **200** communicates with other devices of a communication network system (e.g., communication network system **100** of FIG. 1A) via input signal **221** and output signal **223**.

In various instances, the TIC server **200** and its components can be located anywhere within a communication network system **100** such as that shown in FIG. 1A. A including, but not limited to, within the UEs **101**, or in separate locations within the communication network system **100** of FIG. 1A. The TIC server **200** can also be provided as on-premise deployment, via private computation clouds, or be embedded into other software or bundled into devices by Original Equipment Manufacturers (OEMs).

As used herein, a module can be, for example, any assembly and/or set of operatively-coupled electrical components, and can include, for example, a memory, a processor, electrical traces, optical connectors, software (executing or to be executed in hardware) and/or the like. Furthermore, a module can be capable of performing one or more specific functions associated with the module, as discussed further below.

In some embodiments, the TIC server **200** can provide an analytics platform as a Software as a Service (SaaS) such that, for example, the TIC services are centrally hosted on the information cloud (not shown) for independent software vendors, system integrators, analytics consultants, enterprises, etc., to build multi-tenant business intelligence and embedded analytics solutions for external and internal customers and/or users, for example, by using a browser. The TIC server **200** can enable users to mashup data from various sources for real-time ad-hoc analysis, build reports with rich visualizations and dynamic dashboards, and collaborate in-place among stakeholders to make informed decisions. The TIC server **200** can provide capability of reducing data into smaller parts or views that can yield more information (e.g., slice and dice), drill downs and search on data. For example, a multi-dimensional data structure can be considered as a data cube and the act of picking a rectangular subset of a data cube by choosing a single value for one of its dimensions can define a new data cube with one fewer dimension (e.g., slice operation). Other operations can produce sub-cubes, for

6

example, by allowing an analyst to pick specific values of multiple dimensions (e.g., dice operation). Furthermore, a drill down/up operation allows the user to navigate among levels of data ranging from the most summarized (up) to the most detailed (down).

In some instances, the TIC server **200** receives an input via the input signal **221** representing a question entered by a user of a UE **101** (as shown in FIG. 1A). The UE **101** in FIG. 1A, for example, can be equipped with input device(s) and a user can enter input signals representing threat indicator visualization settings, parameters, and/or the like, which can be processed by the user input module **204**. In such instances, the TIC calculation module **202** can calculate or dynamically update a TIC score based on TIC calculation rules **219b** in the data store **211**.

The TIC UI presentation module **203** can in turn update the TIC visualization presentation via the user interface based on the updated TIC score, and visualization templates **219c**. In another example, the input signal **221** may include a threat indicator sent from a data source (e.g., see **111** in FIGS. 1A-B, etc.), and the threat indicator input signal **221** may be processed at the threat indicator module **201**; and the threat indicator can be stored at a threat indicator table **219a** (example data structure of a threat indicator is provided at **205** in FIG. 2B and described below).

In various instances, the output signal **223** may include a variety of data outputs, such as a generated TIC score, information for a visual presentation (e.g., data plots, charts, etc.) of the TIC score, and/or the like. Example TIC score visualization are provided in FIGS. 3A-3C and discussed in further detail below.

FIG. 2B provides a diagram illustrating an example data structure of a threat indicator, as received at the threat indicator module **201** in FIG. 2A, according to an embodiment. As shown in FIG. 2B, the TIC server **210** may receive a threat indicator **205** from the source **220**. The threat indicator **205** may include an overall threat indicator **206**, e.g., "Dark-mailer" associated with an overall risk score.

In one implementation, a TIC score is calculated as a rating of the severity of a threat indicator (e.g., **205**). Such a TIC score can be calculated as associated with an independent threat incident, and/or associated with a network because the threat incident can promulgate through the elements of the network. A network element or set of network elements can have an associated TIC score, which represents how threatening the particular element, or set of elements is. A network element or set of network elements that has a TIC score is defined as a TIC asset. The network elements can be, for example, an individual element described by a specific IP address. A set of network elements can include, for example, Classless Inter-Domain Routing (CIDR), IP Range or collection of network domains, Fully Qualified Domain Names (FQDNs), and/or the like.

For example, the TIC calculation module (e.g., see **202** in FIG. 2A) can receive a threat indicator tag, which can include, for example, any of the four factors (1) the rating of the source feed; (2) the classification rating of the threat indicator tag; (3) the criticality of the threat indicator tag; and (4) the time since the threat indicator tag was created or last updated. Each of the first three parameters (1)-(3) ranges from 0 to 1. For example, the threat indicator tag score could be calculated as one minus a product of the ratings (1)-(3). The TIC calculation module can send the threat indicator tag through a network of elements/assets, so that a TIC asset score can be calculated at each node in a web of network assets, e.g., as a sum of TIC tag scores of threat indicator tags that pass

through the node, etc. Further implementations of calculating a TIC asset score are discussed in FIG. 4.

The overall threat indicator score **206** can be built upon a data structure of an object model, including characteristics and/or parameters such as Classification **206a**, Criticality **206b**, and Source **206c**. A pseudo code example data structure of the threat indicator object model may take a form similar to:

```

Class {Indicator}
  name/string as a key
  one or more Classifications;
  one Source;
  a riskScore that is the numerical combination of Criti-
    cality, Classification Rating
    and Source Rating
  a numerical Criticality (e.g., 1 to 100; 100 being most
    critical)
...
Class {Classification}
  a name/string as a key
  a numerical Rating (1 to 100)
  associated with one or more Indicators
...
Class {Source}
  a name/string as a key
  a numerical Rating (1 to 100)
  contains 1 or more Indicators
...
  
```

FIGS. 2C-2D provide an example network infrastructure illustrating calculation of a threat indicator confidence score at the TIC calculation module **202** in FIG. 2A according to one embodiment.

For example, as shown at FIGS. 2C-2D, continuing on at **207**, the IP addresses **209a-d** can be assigned a TIC score from the threat indicator (e.g., **207**) tagged to the respective IP addresses **209a-d**. The threat indicator (e.g., **207**) including the parameters in the threat indicator can be inherited by CIDR **208b-c** from IP addresses **209a-d**. For instance, the CIDR **208b** can inherit the threat indicator parameters **207a-b** from IP address **209b**; the CIDR **208c** can inherit the threat indicator parameters **207c-e** from IP addresses **209c-d**. The network element such as an automatic system (AS) **208a** can in turn inherit all threat indicator characteristics and/or parameters **207a-e** from the CIDRs **208b-c**, and receive a TIC score based on the average of the threat indicators from the IPs (e.g., traced back to **209a-d**) attached to the indicator.

Continuing on with FIG. 2D, FQDNs **212** can further inherit the TIC scores based on the threat indicator (e.g., **207** in FIG. 2C) and the IP addresses (e.g., traced back to IP addresses **209c-d** in FIG. 2C, and also shown in FIG. 2D). A project tag **211** may receive a TIC score based on the CIDR **208d** and/or the IP address **209e** attached.

FIGS. 3A-3C provide example UI screens illustrating aspects of an interactive threat indicator confidence score rating editor, as generated by the TIC UI presentation module **203** at FIG. 2A, according to one embodiment. In one embodiment, the TIC platform (e.g., **103** in FIG. 1A; **200** in FIG. 2A, etc.) may provide a TIC editor including a graphical interface widget that allows a user to configure ratings of classification, source and criticality associated with a threat indicator and observe the impact of each parameter impacts other indicators associated with that source and/or classification. The UI diagrams shown in FIGS. 3A-3C may be presented at a UE (e.g., see **101** in FIG. 1A).

In one implementation, the TIC editor shows a TIC score (or a risk score) **303** and its relationship to classification/ source information, such as, but not limited to criticality

**302a**, classification of source **302b**, classification of threat **302c**, source **302d**, and/or the like. As shown at **303** in FIG. 3A, the TIC Score **303** shows the overall score via a widget **301**, which shows the overall score via a vertical line and across each of the sub-parameters **302a-d**.

For each row in the UI, a threat indicator characteristic and/or parameter (e.g., Criticality **302a**, Classification **302b-c**, Source **302d**) is shown and its current value represented by a slider bar that shows the “weight” (and/or user rating) of that parameter has on the TIC score or risk score **303**. The position of the slider bar and its middle point shows the current value of that particular parameter. This UI shows the relationship of each parameter has on the final risk score of the indicator.

For example, a user can click on the left and right arrows next to the TIC Score **303** as well as dragging the vertical bar **301** below the number to override all characteristic or parameters (e.g., **302a-d**) influence on the TIC score **303**. When the TIC score **303** has been adjusted by a user, the characteristic or parameter values (e.g., **302a-d**) can be automatically rearranged to match the changed TIC score. By doing so the user need not be knowledgeable about all characteristic or parameter values. In another example, the user can select a characteristic or parameter row (e.g., any of **302a-d**), and move the sliding bar to submit a rating or weight value for the selected characteristic or parameter; and the TIC score **303** can in turn be re-calculated and dynamically updated based on the user submitted rating or weight value.

With reference to FIG. 3B, which provides an alternative view or equivalent of the UI of threat indicator editor, a user can move the slider bar **304** next to the Criticality row or drag the slider bar left or right to adjust the Criticality weight/rating. The TIC score **303** can automatically updates and the sliding bar indicating the TIC score would automatically adjusts in response to any changes to the sliding bars **304a** made by the user.

In another example, the user can first click on the classification that they wish to modify, which can then lead to an additional set of TIC scores associated with that classification. In this way, the user can view all TIC scores that are associated with that classification and by modifying the classification rating value (via the sliding bar **304b-c**) all of those TIC scores will be updated. For example, the UI may provide a notification that all associated TIC scores may be updated, e.g., at **306**.

In another example, in a similar manner as modifying the classifications **302b-c**, a user can modify the source information **304d**, which may impact all TIC indicator scores from that source.

With reference to FIG. 3C, the TIC editor can show multiple threat indicator confidence scores, e.g., see **301a-301b**, in one panel or screen. A user may click on each tab of the TIC scores **301a-d**, and view the respective rows of parameters (Criticality, Classifications, Source) associated with the selected TIC score. In other words, the display of parameter/ characteristic value changes as a different, corresponding TIC score is set by a user.

FIG. 4 provides a network infrastructure diagram illustrating sending a threat indicator tag through a network to calculate a TIC asset score, according to one embodiment. In one implementation, once a single TIC score(s) associated with a single threat indicator tag is calculated, the TIC score(s) are sent into a web of network assets via messages that start at the node attached to the threat indicator tag (e.g., **401**). The web of network assets, as shown in FIG. 4, can include undirected transmission paths between FQDNs **405a-b** and devices with IP addresses **402a-f**, as well as directed transmission from devices with IP addresses **402a-c** to CIDRs **403a-b** and from

CIDRs 403a-b to autonomous systems (AS) 404. Undirected edges such as the lines connecting 402d to 405b, 402e to 405b, and/or the like, can allow threat indicator tag influence to flow across a given edge, regardless which direction the influence is coming from; directed transmission edges can allow threat indicator tag influence to only flow in the direction of the arrows.

To avoid loop influence by a threat indicator tag on network assets, the TIC calculation module can use Dijkstra's breadth first search to propagate the threat indicator tag information along the network shown in FIG. 4, which means that all the nodes one hop away from the node where the threat indicator tag was originally attached (e.g., 401) have the tag information sent to it. Then all the nodes two hops away from the node where the threat indicator tag was originally attached (e.g., 401) have the threat indicator tag information sent to them, and so on. This process continues until the significance of the threat indicator tag information decreases to a point where further propagation will no longer affect TIC scores.

As the threat indicator tag information propagates from one node to another, its message strength decreases. The message strength starts with value 1 at the initial node to which the threat indicator tag is attached (e.g., 401), and decreases as the threat indicator tag information propagates away from the node. At each step, a decrease term is multiplied to the strength (the term is <1).

When the threat indicator tag information is passed through a node, an additional decrease term is applied. This term is equal to 1/(the number of connected outbound nodes). If the node that accepts the threat indicator tag information has five connected nodes, and the incoming threat indicator tag information came from one of the connected nodes, then the threat indicator tag information needs to be passed out through the other 4 connected nodes. Each of these threat indicator tag information has 1/4 strength after the transmission.

In one implementation, the TIC asset score at a node is calculated as the collection of attached threat indicator tag information according to the following formula (for FQDNs and IPs).

$$TIC = \prod_i (1 - Tag_i)^{Message\_Strength_i}$$

where CIDRs and AS may use the same formula for the same threat indicator tag information.

It is intended that the systems and methods described herein can be performed by software (executed on hardware), hardware, or a combination thereof. Hardware modules can include, for example, a general-purpose processor, a field programmable gate array (FPGA), and/or an application specific integrated circuit (ASIC). Software modules (executed on hardware) can be expressed in a variety of software languages (e.g., computer code), including C, C++, Java™, Ruby, Python, JavaScript, Perl, PHP, Visual Basic™, and other object-oriented, procedural, or other programming language and development tools. Examples of computer code include, but are not limited to, micro-code or micro-instructions, machine instructions, such as produced by a compiler, code used to produce a web service, and files containing higher-level instructions that are executed by a computer using an interpreter. Additional examples of computer code include, but are not limited to, control signals, encrypted code, and compressed code.

Some embodiments described herein relate to a computer storage product with a non-transitory computer-readable medium (also can be referred to as a non-transitory processor-readable medium) having instructions or computer code thereon for performing various computer-implemented operations. The computer-readable medium (or processor-readable medium) is non-transitory in the sense that it does not include transitory propagating signals per se (e.g., a propagating electromagnetic wave carrying information on a transmission medium such as space or a cable). The media and computer code (also can be referred to as code) may be those designed and constructed for the specific purpose or purposes. Examples of non-transitory computer-readable media include, but are not limited to, magnetic storage media such as hard disks, floppy disks, and magnetic tape; optical storage media such as Compact Disc/Digital Video Discs (CD/DVDs), Compact Disc-Read Only Memories (CD-ROMs), and holographic devices; magneto-optical storage media such as optical disks; carrier wave signal processing modules; and hardware devices that are specially configured to store and execute program code, such as Application-Specific Integrated Circuits (ASICs), Programmable Logic Devices (PLDs), Read-Only Memory (ROM) and Random-Access Memory (RAM) devices.

While various embodiments have been described above, it should be understood that they have been presented by way of example only, and not limitation. Where methods and steps described above indicate certain events occurring in certain order, the ordering of certain steps may be modified. Additionally, certain of the steps may be performed concurrently in a parallel process when possible, as well as performed sequentially as described above. Although various embodiments have been described as having particular features and/or combinations of components, other embodiments are possible having any combination or sub-combination of any features and/or components from any of the embodiments described herein.

What is claimed is:

1. A system, comprising:

a processor, and

a memory operatively coupled to the processor, the memory storing processor-readable instructions executable by the processor to:

instantiate a user interactive risk evaluation component having a user interface input element for a user to submit calculation weights for one or more characteristics of a cyber threat;

generate a graphical representation of a cyber threat confidence score for user interface display via the user interactive risk evaluation component,

the cyber threat confidence score being calculated based on the one or more characteristics of the cyber threat, the one or more characteristics of the cyber threat including a threat tag score and a threat asset score, the threat asset score being calculated by propagating a threat tag through a web of assets and integrating threat tag scores of the assets;

receive a user configured weight for one of the one or more characteristics via the user interface input element; and

dynamically adjust the graphical representation of the threat confidence score using at least one of the one or more characteristics weighted by the user configured weight.

2. The system of claim 1, wherein the one or more characteristics include any of: a threat indicator identifier, a threat classification, a threat criticality level and a threat source.



## 11

3. The system of claim 1, wherein the user interface input element is configured to control a sliding bar.

4. The system of claim 1, wherein the threat confidence score includes any of a negative or a positive indication of cyber risk.

5. The system of claim 1, wherein the threat tag score is calculated based on any of:  
a rating of a source feed of the cyber threat indicator;  
a classification rating of a tag of the cyber threat indicator,  
the tag indicative of a type of the cyber threat;  
a criticality of the tag; and  
time lapse since the tag was created or last updated.

6. The system of claim 1, wherein the user configured weight includes a numeric value between 0 and 1.

7. The system of claim 1, wherein the graphical representation includes a moving scale widget.

8. A non-transitory processor-readable medium storing code representing processor-executable instructions, the code comprising code to cause the processor to:

receive a cyber threat indicator associated with one or more rating characteristics of a cyber threat, the one or more rating characteristics including a threat indicator score and a threat asset score, the threat asset score being calculated by propagating a threat tag through a web of assets and integrating threat tags scores of the assets;  
instantiate a user interactive risk evaluation component having a user interface input element that can receive a user-configured rating for a set of characteristics from the one or more rating characteristics associated with the cyber threat indicator;

receive an indication representing the user-configured rating for the set of characteristics from the one or more characteristics via the user interface input element;  
calculate a threat confidence score using the characteristic from the one or more characteristics rated by the user-configured ratings; and

generate a graphical representation of the threat confidence score for user interface display via the user interactive risk evaluation component.

9. The medium of claim 8, wherein the one or more rating characteristics include a threat indicator identifier, one or more threat classification ratings, a threat criticality level and one threat source rating.

## 12

10. The medium of claim 8, wherein the user interface input element is configured to control a sliding bar.

11. The medium of claim 8, wherein the threat indicator score is calculated based on at least one of:

a rating of a source feed of the cyber threat indicator;  
one or more classification rating of a tag of the cyber threat indicator, the tag indicative of a type of the cyber threat;  
a criticality rating of the tag; or  
time lapse since the tag was created or last updated.

12. The medium of claim 8, wherein the user-configured rating includes a numeric value between 0 and 1.

13. The medium of claim 8, wherein the graphical representation includes a moving scale widget.

14. A non-transitory memory storing a plurality of processor-issuable processing instructions to provide an interaction interface having a plurality of interaction interface mechanisms comprising:

a display interface mechanism configured to display a graphical representation of a threat confidence score to a user, the threat confidence score being calculated based on one or more cyber threat characteristics, the one or more cyber threat characteristics including a threat tag score and a threat asset score, the threat asset score being calculated by propagating a threat tag through a web of assets and integrating threat tag scores of the assets; and  
a user configurable interface mechanism including one or more user input elements configured to receive from a user a weight associated with a cyber threat characteristic, the threat confidence score being re-calculated based on the cyber threat characteristic scaled by the weight to produce an updated threat confidence score,

the display element configured to display the graphical representation of the threat confidence score being dynamically updated with the updated threat confidence score.

15. The interaction interface of claim 14, wherein the user interface input element is configured to control a sliding bar.

16. The interaction interface of claim 14, wherein the user interface display element includes a moving scale widget.

17. The interaction interface of claim 14, wherein the display element is configured to display multiple selectable tabs, each tab from the multiple selectable tabs, when selected, configured to display a different threat confidence score.

\* \* \* \* \*